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SUSPENDED SEDIMENT TRANSPORT AT PRICE INLET, SOUTH CAROLINA,(U)
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Despite several simplifying assumptions, the results show a fair correspondence between Qe and Qs. A regression line, log Qe = .95 log Qs, incorporates almost half the data points within the 95% confidence limits and accounts for 95% of the variation. This relatively close correspondence between Qe and Qs indicates that suspended load accounts for the major portion of sand transported alongshore in the littoral zone.

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SUSPENDED SEDIMENT TRANSPORT AT PRICE INLET, S.C.

Timothy W. Kana[1]

ABSTRACT

Daily longshore transport rates were estimated two ways near Price Inlet, S. C. between August and November 1975. A transport rate, Qe, was calculated from the longshore component of wave energy flux and compared with a suspended sediment transport rate, Qs, determined from suspended sediment concentration and longshore current velocity. Over 650 "instantaneous" water samples were collected in the surf zone to establish the typical distribution of sediment in suspension from 4 cm above the bed to the surface. Concentrations range to as much as 50 kg/m^3 at 10 cm above the bed, but the mean for all sample elevations is less than 1 kg/m^3.

Despite several simplifying assumptions, the results show a fair correspondence between Qe and Qs. A regression line, log Qe = .95 log Qs, incorporates almost half the data points within the 95% confidence limits and accounts for 95% of the variation. This relatively close correspondence between Qe and Qs indicates that suspended load accounts for the major portion of sand transported alongshore in the littoral zone.

INTRODUCTION

Coastal engineers often require estimates of littoral transport rates in order to predict the effect of proposed structures on beaches. Transport rates can be determined in areas where a natural or artificial sand trap interrupts the littoral drift. The rate is measured by calculating volumetric changes along the beach and nearshore zone updrift from the trap and then integrating the result with time. However, transport rates along uninterrupted, straight beaches must be estimated by other methods.

Two methods were used along two undeveloped beaches adjacent to Price Inlet, S. C., to estimate longshore transport rates. The first is the commonly applied energy flux method (Coastal Engineering Research Center, 1973; Galvin, 1977), in which a daily transport rate, Qe, is related empirically to the longshore component of wave energy flux, P_{ls}, by:

$$Qe = k \cdot P_{ls} \tag{1}$$

where P_{ls} is measured in ergs/m·s and k is a coefficient to give Qe in metric tons/day. The second method estimates a transport rate from

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measurements of suspended sediment concentration in the surf zone. A suspended sediment flux transport rate per unit width, Qs, is calculated from the general equation

$$Qs = \frac{k_s}{n} \overline{\sum_{i=1}^{n} C_i \; A_i \; V_i} \quad (2)$$

where C is the concentration of suspended sediment in the surf zone (kg/m^3), A is the cross sectional area of the surf zone over which C is applied (m^2), V is longshore current velocity in m/s, k_s is a conversion factor to give Qs in metric tons/day, and the bar implies a time average over one day.

The purpose of this paper is to describe the technique used to measure transport rates from suspended sediment flux, compare the results with those predicted from wave energy flux, and discuss the relative importance of the suspended component of longshore transport.

PREVIOUS WORK

Several theories existing today can be applied to littoral transport problems along open coasts. While none of these theories yields a precise transport rate, there is some basis from empirical data for their use (Das, 1972; C.E.R.C., 1973). At present, the most reliable and, certainly most convenient, way to estimate longshore transport on open beaches is to use the C.E.R.C. (1973) rating curve relating wave energy flux to a yearly transport rate. This empirical curve is largely based on field observations by Komar and Inman (1970) at two West Coast beaches, in which they measured transport rates using dyed-sand tracers and related them to the direction and flux of wave energy in and near the surf zone. Tracer studies do not directly measure the rate of sand movement, but infer a transport rate by measuring the time rate of change of the tracer center of gravity. Another tracer study for Bulls Island, S. C., relating transport rate to wave energy (Knoth and Nummedal, 1977) fits the C.E.R.C. rating curve quite well.

Attempts to measure sand movement in the surf zone suffer from a lack of adequate equipment to measure the simultaneous distribution of longshore currents and suspended and bedload in the littoral zone. According to C.E.R.C., (1973, p. 4-54), "...the practical difficulty of obtaining and processing sufficient suspended sediment samples (has) limited (the suspended sediment flux) approach to predicting longshore transport". Thornton (1969) estimated a sediment flux alongshore using current meters to establish velocity profiles and a bed-mounted sampler to calculate the load moving within 20 cm of the bed. His results show a good correspondence between measured and predicted transport rates outside the breaker zone, but do not compare as well in the surf zone, due, possibly, to high transport rates and low trap efficiency (Thornton, 1969).

Fairchild (1972) used a tractor-mounted pump sampler to measure time-averaged concentrations of suspended sediment at various elevations above the bed. He combined longshore current velocity measurements with suspended sediment data, then integrated the results across the

surf zone to estimate longshore transport rates. His results for Ventnor, N. J. and Nags Head, N. C. are approximately an order of magnitude less than those predicted by the C.E.R.C. rating curve.

Probably, the best information on instantaneous fluctuations of suspended sediment in the field is that obtained by Brenninkmeyer (1974). Using an almometer, an array of photoelectric sensors placed in the surf zone, he recorded voltage changes corresponding to the variation in turbidity. By means of a calibration curve, the voltage is related directly to suspended sediment concentration. Brenninkmeyer has detected concentrations ranging from 6-10 kg/m^3 to several hundred kg/m^3. These values are at least an order of magnitude higher than concentrations measured directly from water samples collected by Watts (1953a) and Fairchild (1972). Since the threshold concentration that can be detected is high compared with the typical concentration found in the surf zone, this writer does not consider the almometer suitable for quantifying the suspended sediment flux.

In the present study, direct sampling of the water column was deemed the most reliable for calculating the suspended sediment concentration. Consequently, a technique similar to Fairchild's was used to compute the suspended sediment flux. The major difference is the method used to collect water samples in the surf zone. Fairchild pumped single-depth, time-averaged samples from an ocean pier; whereas, we collected multi-depth instantaneous samples in situ. A later section contains a description of our sampling apparatus. It should be pointed out that both systems account only for sediment moving in suspension.

STUDY AREA

Between August and November 1975, littoral process measurements and suspended sediment samples were routinely collected at four beach stations near Price Inlet, South Carolina (Fig. 1), a mesotidal barrier island coastline. Two of the stations (PI1, ½ km to the north on Bulls Island, and PI9, ½ km to the south on Capers Island) are located in close proximity to the ebb-tidal delta of the inlet. The beaches at PI1 and PI9 contain well developed ridge-and-runnel systems and are exposed to a wave regime modified by wave refraction around the inlet's ebb-tidal delta. Between August 1975 and July 1976, the beach at PI1 retreated 10 m, whereas, PI9 accreted slightly, as the southern swash bar complex of the delta enlarged and extended southward past the station.

The other stations (BU2, about 2 km north of Price Inlet and CA1, 2 km south on Capers Island) are located away from direct influence of the ebb-tidal delta. The beach at BU2 maintains a poorly developed ridge-and-runnel system, whereas, CA1 typically shows an erosional profile (Fig. 1). During the fall of 1975, the beach at BU2 was stable and at CA1 eroded more than 1 meter.

The median grain size of sediment on beaches along this section of coast is 0.22 mm - fine sand. Bascom (1951) was among the first to recognize that beaches establish a beach face slope directly related to grain size. For 0.22 mm sand, the corresponding beach slope is $\tan \beta =$

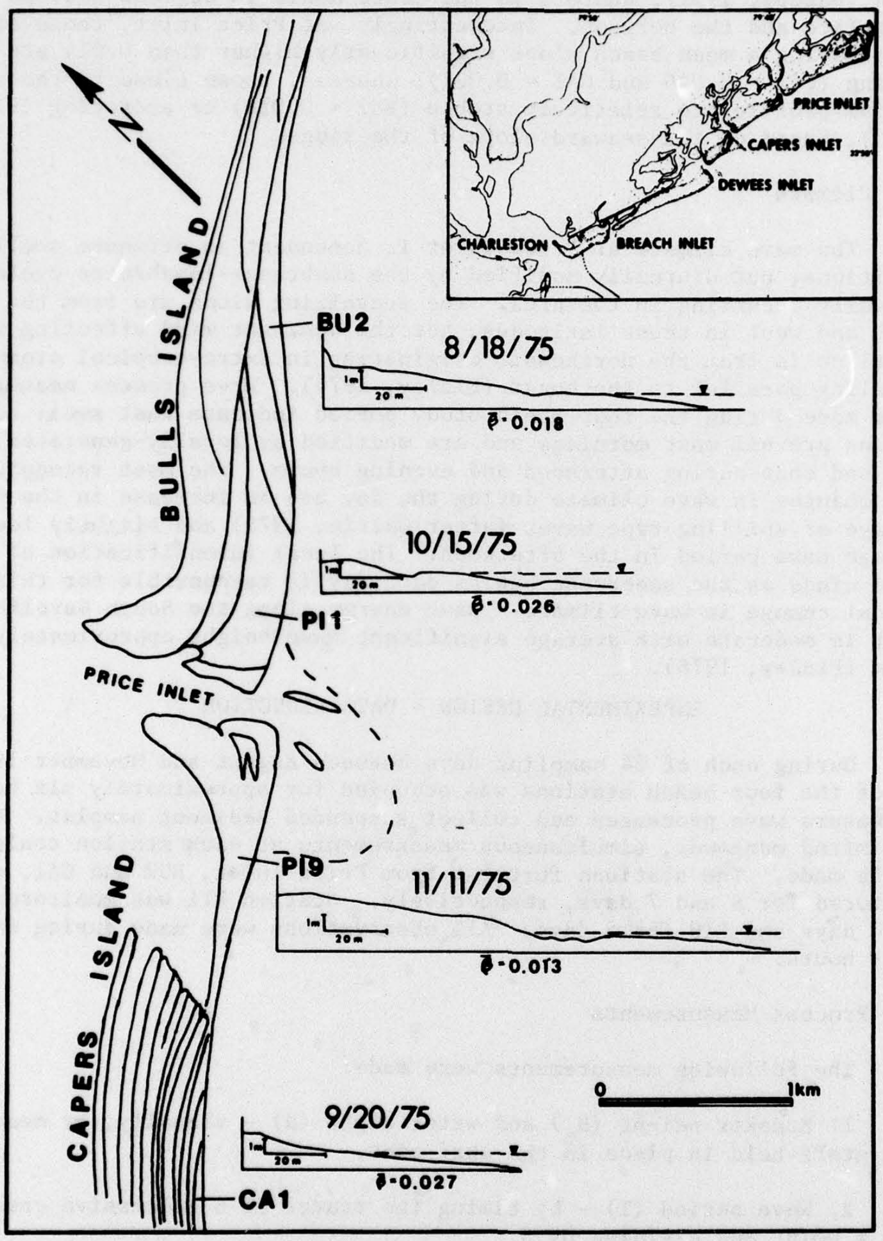

Figure 1. Location map of four beach stations near Price Inlet, South Carolina, showing typical beach profiles. Between August 1975 and July 1976, BU2 was stable, PI1 eroded 10 m, PI9 accreted slightly due to its proximity to the ebb-tidal delta swash platform, and CA1 eroded approximately 3 m. The erosion rate at CA1 would presumably be much higher if forest vegetation were not tending to stabilize the area.

0.014 (Bascom, 1951), where β is the acute angle in degrees between the beach face and the horizon. Interestingly, at Price Inlet, those stations having a mean beach slope significantly higher than 0.014 are eroding (PI1 = 0.026 and CA1 = 0.027); whereas, those close to the equilibrium profile are relatively stable (BU2 = 0.018) or accreting (PI9 = 0.013), based on the seaward slope of the ridge.

Wave Climate

The wave climate at Price Inlet is dependent on offshore swell conditions, but diurnally modified by the seabreeze-landbreeze cycle typically occurring in the area. The prevailing winds are from the south and west in these latitudes, but the dominant wind affecting the coastline is from the northeast, originating in extra-tropical storms traveling parallel to the coast (Finley, 1976). Wave process measurements made during the four month study period indicate that swell conditions prevail most mornings and are modified by locally-generated seas and chop during afternoon and evening hours. The most recognizable changes in wave climate during the day are an increase in the percentage of spilling-type waves (after Galvin, 1972) and slightly lower average wave period in the afternoon. The local intensification of onshore winds as the seabreeze begins each day is responsible for this diurnal change in wave climate. Wave energy along the South Carolina coast is moderate with average significant wave height approximately 60 cm (Finley, 1976).

EXPERIMENTAL DESIGN - DATA REDUCTION

During each of 24 sampling days between August and November 1975, one of the four beach stations was occupied for approximately six hours to measure wave processes and collect suspended sediment samples. Due to limited manpower, simultaneous measurements at each station could not be made. The stations furthest from Price Inlet, BU2 and CA1, were monitored for 8 and 7 days, respectively. Station PI1 was monitored for 4 days and PI9 for 5 days. All observations were made during daylight hours.

Wave Process Measurements

The following measurements were made:

1. Breaker height (H_b) and water depth (d) - visually, by means of a staff held in place in the surf zone.

2. Wave period (T) - by timing the travel of 6 successive crests past a point and dividing by 5.

3. Breaker angle (α_b) - by means of a Brunton compass, sighting the acute angle between wave crest and shoreline.

4. Breaker type - qualitatively by visual observations in the field, verified by photos taken while sampling.

5. Longshore current velocity (V) - by timing the travel of a small float between stakes set 10 m apart, alongshore, in the surf zone.

Table 1 summarizes the wave process measurements obtained at each station.

Suspended Sediment Samples

Vertical arrays of two-liter water samples were collected in the surf zone with a portable apparatus (Kana, 1976), which simultaneously collects several closely spaced "instantaneous" samples (Fig. 2). The sampler consists of a series of stubby, cast acrylic tubes equipped with hinged doors held shut by elastic tubing. Each "bottle" is mounted across a wooden support pole, which can be held vertically in the water column. To ready the sampler for use, all the doors are opened and held in place by a "trigger" assembly (Fig. 2) in a manner similar to rigging a Van Dorn sampler. To collect an array of samples, the entire apparatus is thrust into the bed in the surf zone at the desired instant. This forces the trigger assembly open, the doors release and spring shut simultaneously to trap the sample. Response time of the sampler is less than half a second which enables the operator to detect short period fluctuations in sediment suspended in breaking waves. Although samples can be collected every 20 cm, we typically collect samples centered at 10, 30, 60 and 100 cm above the bed. Because of the relatively broad shape of the collecting bottles, the lowermost sample ranges from 4 to 16 cm above the bed.

Concentrations of suspended sediment were obtained by measuring the volume of the water sample, then filtering and collecting all sediment coarser than 1.2 μ. Concentrations were calculated as a mass per unit volume.

Suspended sediment samples were located according to position within the surf zone and elevation above the bed, as well as relative to the position of the wave break point. All samples used in the analysis were collected between 1 and 2 seconds after passage of a wave bore. Sixty-five percent of the samples were obtained between 1 and 3 meters landward of the breakpoint.

Using this device, we made over 700 mass determinations of suspended sand concentration in 250 waves ranging from 10 to 150 cm in height. The samples collected between August and November 1975 appear to represent the typical wave climate along the South Carolina coast. Finley (1976), for example, has recorded a similar range of wave heights (10-190 cm) during four extensive seasonal surveys at North Inlet, S.C. Included in the present data are several dozen suspended sediment samples collected during two minor northeast storms.

Longshore Transport from Wave Energy Flux

Daily longshore transport rates at each station were estimated from wave process measurements. It can be shown that the longshore component of wave energy flux, P_{ls}, is related to breaker height (H_b) and breaker angle (α_b) by (C.E.R.C., 1973, p. 4-98):

$$P_{ls} = k \cdot H_b^{5/2} \cdot \sin 2\alpha_b, \qquad (3)$$

TABLE 1. Wave Parameters Near Price Inlet, S.C. 15 Aug to 1 Dec 1975.

Station North To South	Breaker Height (Hb) cm			Period (T) Seconds		Longshore Current cm/sec			Breaker Angle (αb) Degrees			No. Of Meas.
	Mean	Range	Std. Dev.	Mean	Std. Dev.	Mean Right	Mean Left	% To Right	Resultant Open Right	Resultant Open Left	% To Right	
BU 2	60	10/120	25	9.5	1.2	35	23	80	9	7	68	93
PI 1	65	30/105	23	8.9	1.5	47	-	80	4	-	-	41
PI 9	56	15/130	26	8.3	2.6	34	23	80	5	3	-	36
CA 1	70	10/150	42	9.2	1.5	39	30	60	9	4	65	69
ALL	63	10/150	31	9.1	1.7	38	27	80	7	4	68	239

SPILLING WAVES - 79.8% PLUNGING WAVES - 20.2%

Note: Process measurements were made during a 6 hour daylight period on 24 days. Wave heights and breaker depths were measured visually with a staff; breaker angles using a Brunton compass, sighting the angle between shoreline and wave crests; wave period by timing the travel of a float in the surf zone over a measured distance.

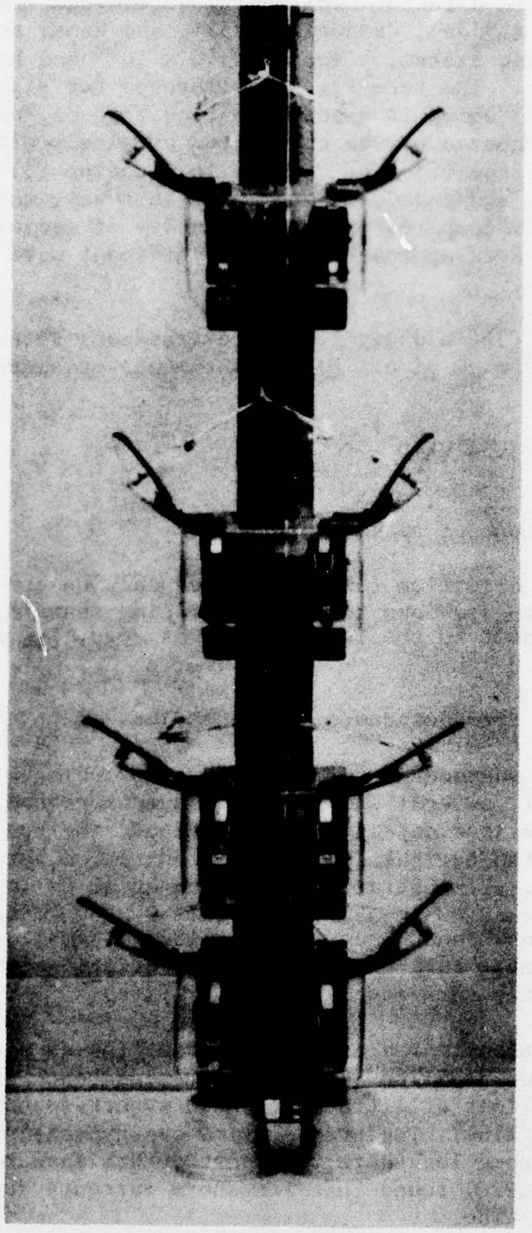

Figure 2. The apparatus used to collect water samples in the surf zone. A 2 m-long pole supporting several 2000 ml bottles is emplaced vertically in the surf zone. When thrust into the bed, a foot pad moves the trigger assembly up, simultaneously tripping each bottle. Top two bottles are rigged for sampling. Bottom bottles are in the tripped position.

where metric units of H_b gives P_{ls} in ergs/ m·s. The coefficient of proportionality, k, is a factor empirically determined from field observations of Watts (1953b), Caldwell (1956), and Komar and Inman (1970). In the metric system, k equals 2.78×10^{10} and has units to balance the equation. The term P_{ls} is calibrated for significant wave height (Galvin, 1977) which is used by most coastal engineers. Since significant wave height cannot be calculated precisely without a continuous wave record, the value of H_b used in equation (3) was that of the wave sampled for suspended sediment. In this way, wave energy can be more realistically compared with the quantity of sediment entrained. For the most part, waves approaching the significant wave height were used in the analysis.

From equation (3), a daily longshore transport rate, Qe, was determined from the average of all P_{ls} measurements obtained during one sample day, by:

$$Qe = 3.54 \times 10^{-7} \cdot \overline{P}_{ls}, \qquad (4)$$

where Qe is metric tons of sediment per day.

The transport direction for each day depends on the direction of α_b, where breaker angles open to the left facing seaward, for example, correspond to transport to the left. If α_b is zero, P_{ls} and Qe will be zero.

Longshore Transport from Suspended Sediment Flux.

To estimate a suspended sediment flux from sediment concentrations obtained in the surf, several simplifying assumptions had to be made. First, the concentrations obtained at 10 cm above the bed (C_{10}) were assumed to represent the typical sediment concentration between 0 and 20 cm above the bed. Concentrations centered at 30 cm (C_{30}) represent the zone between 20 and 40 cm above the bed. The 60 cm samples (C_{60}) were applied between 40 and 80 cm, and the 100 cm samples (C_{100}) between 80 cm and the surface. Furthermore, the concentrations were assumed homogeneous across the surf zone.

The cross-sectional area of the surf zone (A) at each station was calculated from beach profiles, using the average beach slope and assuming the seaward limit of littoral transport corresponds to the position of the breaker line. The breaker line was typically at the 1 m isobath. Although some longshore transport occurs seaward of the breaker zone, Thornton (1970) found that longshore currents decrease rapidly outside the breaker line.

A is calculated by summing segments A_{10}, A_{30}, A_{60}, and A_{100} which correspond to the concentration depth intervals listed above. Segment A_{10}, for example, is the area over which concentration C_{10} is applied; A_{30}, the area applied to C_{30}, and so on.

Thus, the total suspended load per unit width of surf zone (Ws) can be approximated for each sample array by:

$$Ws = \sum_{i=1}^{4} C_i \cdot A_i \qquad (5)$$

where i is a subscript used to sum over the depths of the sampling bottles, 10, 30, 60 and 100 cm. Concentration, C_i, is measured in kg/m^3*, A_i is in m^2 and Ws is in kg.

The velocity at which the total suspended load moves is assumed to equal the longshore current velocity, V. Measurements of V were made just landward of the breaker line, where, according to Thornton (1970) and Jonsson et al. (1974), the highest currents in the surf zone are found. Applying V uniformly across the surf zone overestimates the transport velocity to some degree since longshore current velocity decreases in the swash zone; however, this is offset somewhat by using a smaller A which excludes all transport seaward of the breaker line.

An instantaneous suspended sediment transport rate per unit width, Q, can then be calculated by:

$$Q = Ws \cdot V, \qquad (6)$$

where V in m/s gives Q in terms of kg/s.

A value of Q was calculated for each array of suspended sediment samples for a total of approximately 250 arrays. The results were then broken down by station and date and averaged to estimate the daily suspended transport rate, Qs, by:

$$Qs = \frac{k_s}{n} \cdot \sum_{i=1}^{n} Qi \qquad (7)$$

where k_s is a coefficient equaling 86.4 to convert kg/s to metric tons/day. This puts Qs in terms which can be compared with Qe, the transport rate predicted from wave energy flux.

Figure 3 is presented to illustrate the method used to calculate Q. Using station CA1 as an example, four concentration values (C_{10}, C_{30}, C_{60}, and C_{100}) are obtained in one array of samples and applied throughout cross-section intervals A_{10}, A_{30}, A_{60}, and A_{100}, respectively. The beach slope at CA1 was 0.025 on 19 September, and the breaker line was located at the 1 m isobath. This allows A to be calculated for each interval. Ws is then the mass of suspended sediment per unit width of shoreline contained within cross section A, assumed to move alongshore at V m/s, the longshore current velocity. Thus, in this example, the instantaneous transport rate, Q, is 5.2 kg/s, which corres-

* Note: Concentrations are usually given as a mass per unit volume. A concentration of 1 kg/m^3 is approximately equal to 1 gm/l. One g/l is approximately 1 part per thousand.

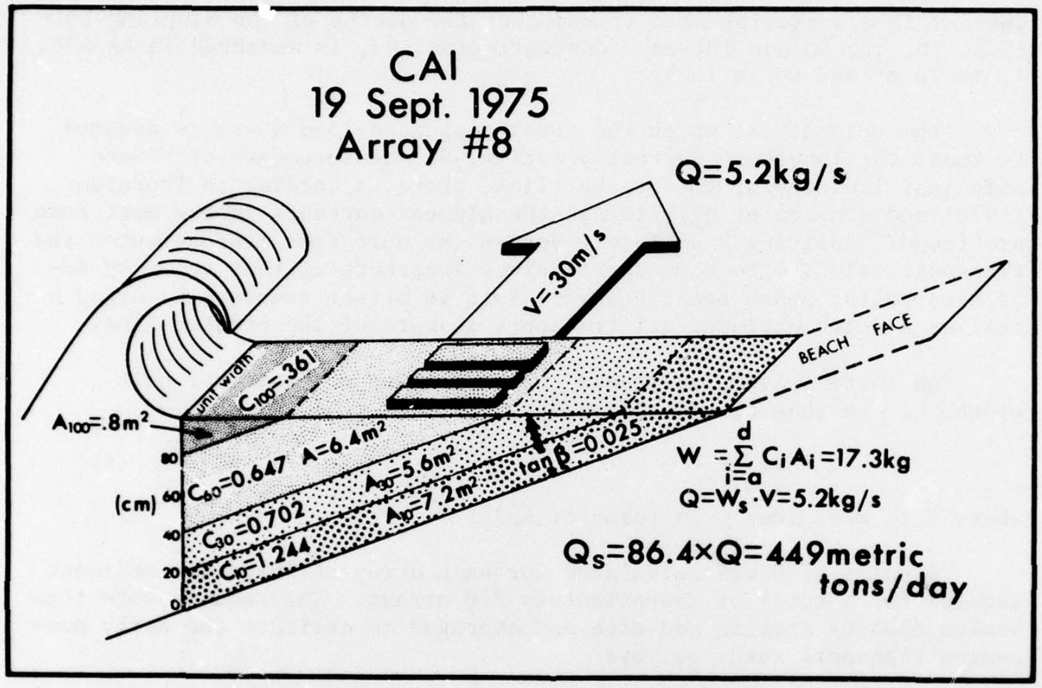

Figure 3. Graphic illustration of the method used to calculate the suspended sediment flux at station CA1 for Array #8 on 19 September 1975. The cross sectional area of the surf zone, A, is estimated from beach profiles and the depth of wave breaking (typically 1 m along this part of the coast). Concentration C_{10} is applied throughout area A_{10}; C_{30} throughout A_{30}, and so on. Longshore current velocity V is assumed uniform across the entire width. Transport seaward of the breaker line is not calculated.

ponds to a daily transport rate, Qs, of 449 metric tons/day.

COMPARISON OF Qe and Qs

Daily sediment transport rates estimated from the longshore component of wave energy flux and suspended sediment concentration are summarized in Table 2. It was considered more appropriate to compare transport rates on a daily basis rather than extrapolating the results over one year, since all data were collected during one season. To put these rates in perspective, an average daily transport of 500 metric tons/day corresponds to a yearly transport of over 180,000 metric tons. This value is of the same order as longshore transport rates reported for the U.S. Atlantic coast (Wiegel, 1964).

Despite several gross assumptions used to estimate Qs, and the error inherent in any measurements of α_b (see Galvin and Savage, 1966 for a discussion), there is a fair correspondence between Qs and Qe. Note that Qe will be zero for all zero breaker angles regardless of wave height. Granted, Qs varies considerably around Qe; but in 15 out of 24 measurements, the difference is less than 50 percent. With one exception, if either Qe or Qs is zero, the other predicted value is less than 280 metric tons. The one anomalous value is from station PI9, located close to Price Inlet, where Qe was zero, and Qs was over 2000 metric tons on 16 October due to the presence of tidal currents near the inlet on that day. Energy flux transport rates are calculated assuming longshore currents are wave generated.

Log Qe is plotted against log Qs (Figure 4) to test the relationship between the two predicted transport rates at each station. The best fit equation for the regression line, which includes all but one data point from station PI9 mentioned above, is log Qe = .95 log Qs (Qe was held as the dependent variable and the line was forced through the origin). With $r^2 = .949$, this line accounts for most of the variation around the predicted value of Qs. Ten out of 23 observations fall within the 95% confidence limits for this line.

DISCUSSION

The fact that Qe and Qs, as calculated in the present paper, are of the same order suggests that suspended load is the most important component of longshore transport inside the surf zone. The relative importance of suspended load and bedload in the littoral zone is still subject to debate (see Komar, 1976 for a discussion). Komar and Inman (1970) concluded that bedload transport is much more significant than suspended load due to equal transport rates measured on beaches having widely different sand sizes. Brenninkmeyer (1974) believes bedload is most important due to the low frequency of high suspended sediment concentrations he detected in the surf zone.

Thornton (1973), however, inferred that suspended load is most important since his bedload traps accounted for just a small portion of the total sand transport. Also, the suspended sediment concentrations measured by Watts (1953a) and Fairchild (1972) indicate that sediment in suspension in the surf zone forms a significant portion of the material in transport.

TABLE 2. Daily Longshore Transport Rates Near Price Inlet, S.C.

STATION	DATE 1975	Qe*	Dir	Qs*	Dir	#meas.	% Difference+
BU2	8-20	191	south	241	south	20	+26
	8-25	0	-	0	-	3	-
	8-25	0	-	198	north	4	-
	9-14	2834	south	4908	south	5	+73
	9-17	848	south	472	south	13	-44
	9-20	0	-	49	south	9	-
	10-11	647	south	212	south	14	-67
	10-15	0	-	61	south	9	-
	10-15	0	-	0	-	8	-
	11-13	323	north	182	north	8	-44
	mean	484	-	632	-	93	+30
CA1	8-21	0	-	280	south	17	-
	8-27	0	-	0	-	6	-
	9-15	2678	south	5431	south	3	+103
	9-19	1219	north	771	north	13	-37
	10-13	98	south	220	south	13	+124
	10-17	3770	north	4420	north	3	+17
	10-18	0	-	207	north	7	-
	10-18	0	-	0	-	5	-
	mean	970	-	1416	-	67	+46
PI1	8-23	0	-	0	-	10	-
	9-13	1535	south	785	south	10	-49
	10-12	392	south	117	south	10	-70
	11-10	509	south	133	south	10	-74
	mean	609	-	259	-	40	-57
PI9	8-26	249	north	267	north	4	+7
	9-14	2289	south	2396	south	4	+5
	9-21	672	south	248	south	4	-63
	10-16	0	-	2083**	south	11	-
	11-11	289	south	149	south	6	-48
	mean	700	-	610	-	29	-13

* metric tons/day + 100%(Qe - Qs)/Qe

** Influenced by tidal currents. Not included in mean.

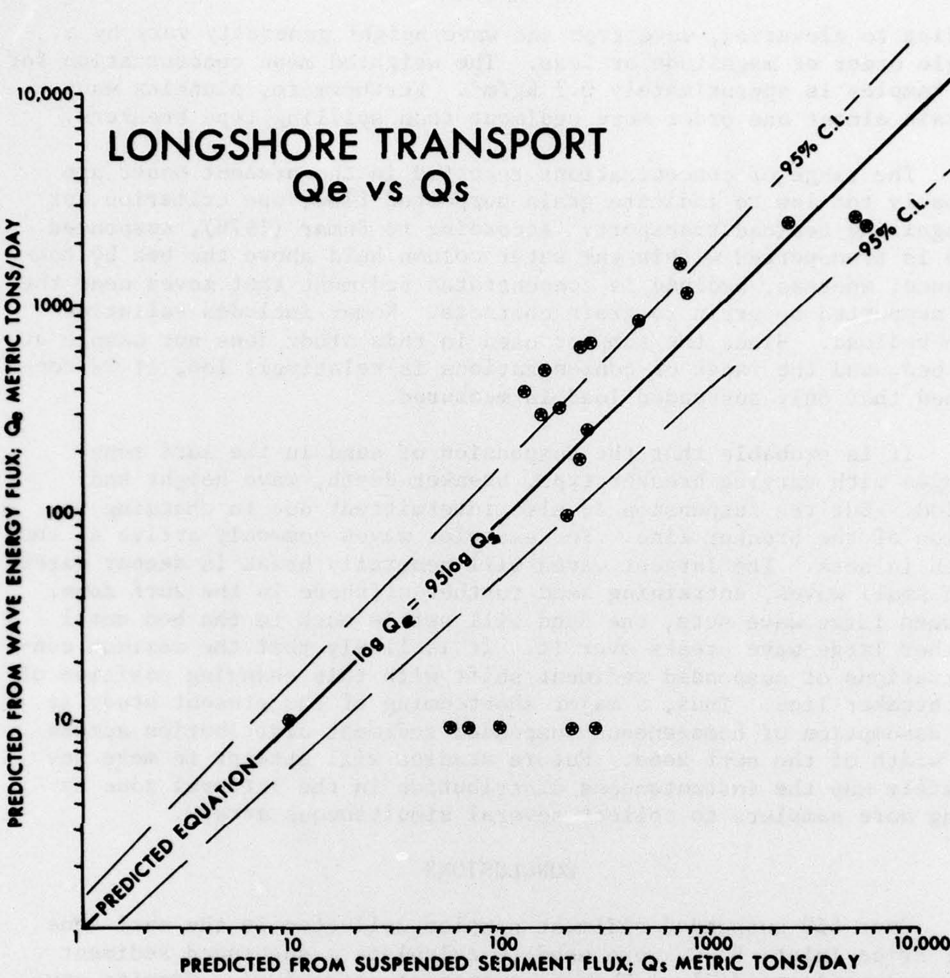

Figure 4. Regression line for log Qe = log Qs, forcing line through origin. Ten of 23 data points fall within the 95% confidence limits for the predicted equation log Qe = .95 log Qs. R^2=.95.

The results contained here further support this conclusion. Abnormally high concentrations of suspended sediment are not required to account for the typical volumes of sand transported along the South Carolina coast. In fact, a concentration of less than 0.5 kg/m^3 distributed equally throughout a surf zone 25 m^2 in cross section, and moving at a typical velocity of 30 cm/s would transport over 120,000 tons/year at any station. This is a reasonable estimate based on wave energy flux for the beaches near Price Inlet, South Carolina.

The typical distribution of suspended sediment landward of the breaker line (Fig. 5) indicates the relatively low concentrations that occur in the surf zone. This distribution is a composite of values obtained under a variety of wave conditions ranging from long period swell to steep, storm waves and ranging in height from 10 to 150 cm. The concentration is most dependent on sample elevation above the bed and breaker type. Although concentrations vary by at least three orders of magnitude from a measured high of 48 kg/m^3, samples grouped ac-

cording to elevation, wave type and wave height generally vary by a single order of magnitude or less. The weighted mean concentration for all samples is approximately 0.7 kg/m^3. Furthermore, plunging waves entrain almost one order more sediment than spilling type breakers.

The range of concentrations reported in the present paper are probably too low to indicate grain supported flow, one criterion for recognizing bedload transport. According to Komar (1976), suspended load is transported within the water column held above the bed by turbulence; whereas, bedload is concentrated sediment that moves near the bed supported by grain to grain contacts. Komar includes saltation with bedload. Since the sampler used in this study does not sample at the bed, and the range of concentrations is relatively low, it is concluded that only suspended load is measured.

It is probable that the suspension of sand in the surf zone changes with varying breaker type, breaker depth, wave height and period. But the suspension is also intermittent due to changing position of the breaker line. For example, waves commonly arrive at the beach in sets. The largest waves will generally break in deeper water than small waves, entraining sand further offshore in the surf zone. Between large wave sets, the sand will settle back to the bed until another large wave breaks over it. It is likely that the maximum concentrations of suspended sediment shift with this changing position of the breaker line. Thus, a major shortcoming of the present study is the assumption of homogeneous suspended sediment distribution across the width of the surf zone. Future studies will attempt to more accurately map the instantaneous distribution in the littoral zone by using more samplers to collect several simultaneous arrays.

CONCLUSIONS

Over 650 suspended sediment samples collected in the surf zone near Price Inlet, S. C. were used to calculate a suspended sediment flux and estimate daily longshore transport rates (Qs). Despite several simplifying assumptions, the resulting values of Qs correspond to transport rates predicted from wave energy flux (Qe) within a factor of two for all non-zero measurements.

The suspended sediment concentration in the surf zone averages less than 1 kg/m^3, but is occasionally upwards of 50 kg/m^3 during rare bursts. Plunging waves entrain almost one order more sediment than spilling breakers.

The relatively close correspondence between Qs and Qe indicates that suspended load accounts for the major portion of sand transported alongshore inside the breaker line.

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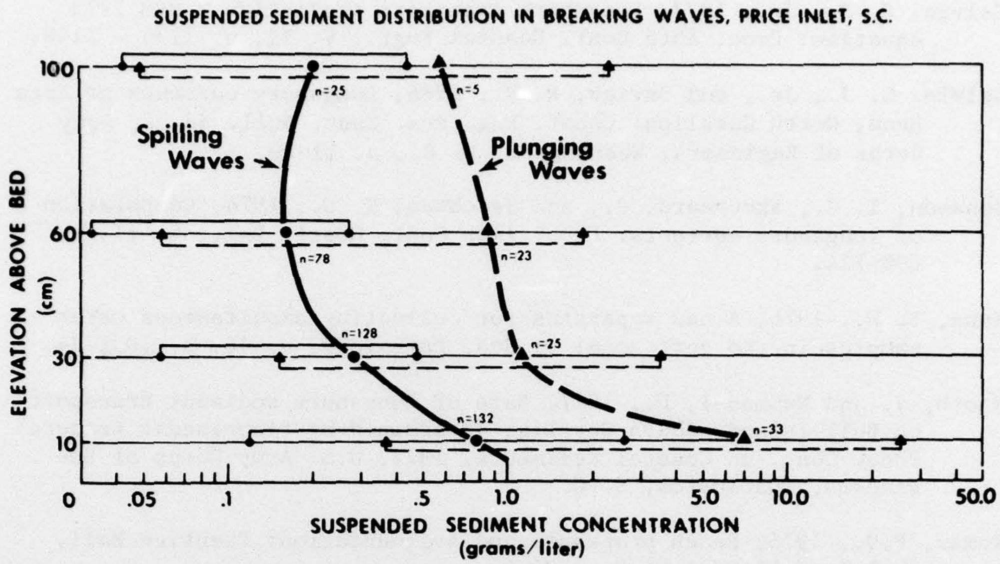

Figure 5. Mean suspended sediment distribution in the surf zone (between 1 and 3 m landward of the breaker line). The indicated ranges of concentrations correspond to the 10th and 90th percentiles for measurements at each sample depth. All samples were collected as breaking waves passed the sampling point.

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